EDIA MEDI

FOCUS MEDIA, INC. / 839 STEWART AVENUE / GARDEN CITY, N.Y. 11530

Software
551.4
Wat

Software551.4 Wat 012

Water and weather.

271146.0002

Software551.4 Wat 012

Water and weather.

271146.0002

FOCUS MEDIA'S
EASY GUIDE TO
START-UP PROCEDURES

Apple II Family

A. With the machine off, carefully insert the disk into the disk drive and close the disk drive door. (If there are two disk drives, use drive 1.)
B. Turn on the computer.
C. The disk will now "boot up" (make the program appear on the screen) automatically.
D. Follow the instructions that appear on the screen in order to move through the program.

IBM-PC, PCjr.

A. With the machine off, carefully insert a copy of your IBM DOS (version 2.1 or higher) into the disk drive and close the disk drive door. (If there are two disk drives, use drive A.)
B. Turn on the computer.
C. When the computer screen displays "Enter new date." press the ENTER key.
When the computer screen displays "Enter new time." press the ENTER key.
D. Replace the IBM DOS disk with the Focus Media program disk.
E. Type: AUTOEXEC and then press the ENTER key. The program will start automatically.

Commodore 64

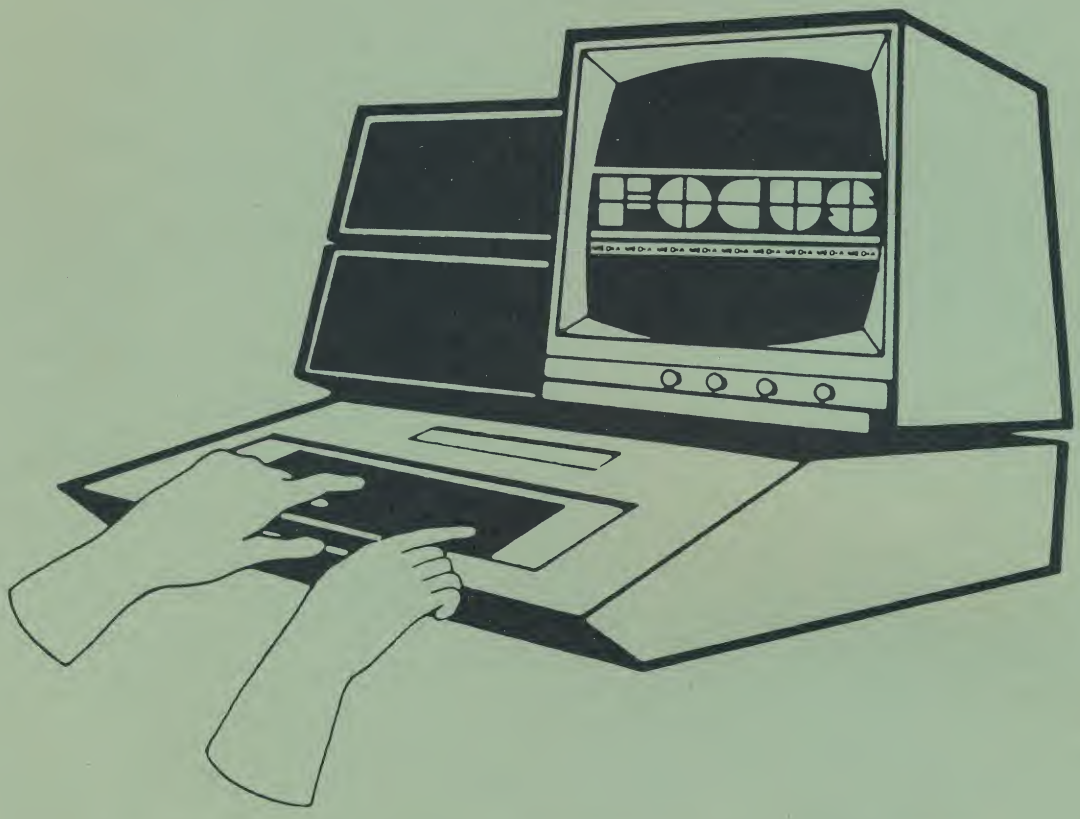
A. Turn on the disk drive, computer, and monitor.
B. Carefully insert the disk and close the disk drive door.
C. Type the following: LOAD "F*", 8.
D. Press the RETURN key.
E. When the computer responds 'READY', type: RUN.
F. Press the RETURN key.
G. Follow the instructions that appear on the screen in order to move through the program.

TRS-80 Models III & 4

A. Turn on the computer.
B. Insert the disk into drive 0.
C. Press the RESET button.
D. When the computer asks for the date, press the RESET button again.
E. The program will automatically load at this point.

Software
551.4
Wat

THE FOCUS MEDIA LESSON PLANNER



WATER & WEATHER

FOCUS MEDIA, INC.
839 STEWART AVENUE
GARDEN CITY, NY 11530
(516) 794-8900
(800) 645-8989

WATER & WEATHER

TEACHER'S LESSON PLANNER

WRITTEN BY: MORRIS GARTNER

COPYRIGHT (c) 1983, FOCUS MEDIA, INC.
839 STEWART AVENUE
GARDEN CITY, NEW YORK, 11530
(516) 794-8900

TABLE OF CONTENTS

THE WATER CYCLE.....3

HUMIDITY.....16

CLOUDS AND PRECIPITATION.....26

WATER & WEATHER ------ THE WATER CYCLE

TESTS YOUR STUDENTS' KNOWLEDGE OF:

A. The process of evaporation and condensation
B. The major sources of water in the air
C. Factors affecting the evaporation rate
D. The process of sublimation
E. The meaning of "saturation" and how it affects condensation
F. The terms: humidity, capacity, dew point, dew
G. The role of condensation nuclei
H. The various components of the water cycle and their roles in that cycle
I. The relationship of the various components of the water cycle to weather and climate

SYNOPSIS OF THE GAME:

In this game, students try for the privilege of becoming a sharpshooter. They do this by answering questions related to THE WATER CYCLE. Each time a correct answer is given, the screen becomes a shooting gallery, during which time they can acquire points by hitting a moving target. If they miss, of course, they get no points.

Any time that an incorrect answer is given to a question, the computer will ask your students if they want some extra help. If the response is "yes," the student will be provided with one or more screens of information about THE WATER CYCLE.

EXTRA HELP SECTION OF THE PROGRAM:

The following extra help screens of information are available and will be furnished when requested. Screens appropriate to the questions missed will appear.

SCREEN 1: FACTS ABOUT EVAPORATION

1. It occurs when liquid water is changed into gaseous water vapor.
2. Water enters the atmosphere from:
   A. oceans (principal source)
   B. lakes, ponds, and streams
   C. soil
   D. snow
   E. even volcanoes
   F. burning of fuels
3. It is caused by heat energy (mainly from the sun).
4. It is a cooling process.

SCREEN 2: FACTORS AFFECTING RATE OF EVAPORATION OF WATER
(HOW FAST WATER EVAPORATES)

1. The more heat energy, the faster water evaporates (water molecules move faster and evaporate faster).
2. The more surface area of the water (the more spread out it is), the faster water evaporates.
3. The less moisture already in the air, the faster water evaporates.
4. The greater the amount of wind, the faster water evaporates.
5. The lower the air pressure, the faster water evaporates.

SCREEN 3: SOME IMPORTANT DEFINITIONS

1. EVAPORATION: Changing liquid water into water vapor
2. TRANSPIRATION: Water vapor entering the atmosphere through plant leaves.
3. SUBLIMATION: Changing a solid directly into a gas (or vice-versa)
4. CONDENSATION: Changing water vapor into liquid water
5. DEW POINT: The temperature at which condensation takes place
6. DEW: Moisture that condenses on cool surfaces
7. FROST: Solid water that condenses on cool surfaces without passing through the liquid phase
8. RUNOFF: Ground water that flows into oceans, streams, reservoirs, etc.
9. EVAPOTRANSPIRATION: A term that combines "evaporation" and "transpiration" of water
10. PRECIPITATION: Condensed water that falls to the earth's surface (rain, snow, etc.)
11. CAPACITY: The amount of moisture the air can hold

WATER & WEATHER ------ THE WATER CYCLE

SCREEN 4: FACTS ABOUT CONDENSATION

1. During condensation, heat is released into the atmosphere (it makes the air warm up).
2. Condensation occurs as fog or clouds.
3. The air holds more moisture when the temperature is higher.
4. If more water can evaporate into the air, the dew point is higher.
5. Water vapor condenses on condensation nuclei (such as dust, smoke, or salt).

SCREEN 5: FACTS ABOUT THE WATER CYCLE

1. It is also called the "hydrological cycle."
2. It consists of evaporation - winds - condensation - precipitation - ground water - runoff - evaporation (again).
3. It can start with any of the above processes.
4. The winds move water vapor and heat energy to different places on the earth.

SCREEN 6: WHAT MAKES A REGION HUMID OR DRY?

A region will be dry if...
    1. there is strong sunlight.
    2. there is little water vapor available.

A region will be humid if...
    1. there is strong sunlight.
    2. there is much water vapor available.

HINTS FOR THE TEACHER:

1. This program can be used as a follow-up to our sound filmstrip programs entitled:

   A. EVAPORATION: WHERE DOES THE WATER GO?
   B. CONDENSATION: THE OTHER SIDE OF THE STORY
   C. THE WATER CYCLE: COMPLETING THE PICTURE

   All 3 (filmstrips) are part of the series: WATER IN THE AIR. (For more information, see the back of this Teacher's Lesson Planner).

2. All questions are multiple-choice.

3. There are 40 different questions available and your students may select any number of questions per game up to 25.

4. You can encourage competition between your students by seeing who can score the most points for the same number of questions.

HINTS FOR THE STUDENT:

1. The game portion of this program involves a shooting gallery. Therefore, you not only need to know about THE WATER CYCLE, but you also need to develop your "sharpshooting" skills.

2. Whenever a YES or NO response is requested, you need only type the letters, Y or N.

3. When asked to select an answer to a question, only the NUMBER of the choice should be typed. Any other response will result in the computer's asking you to indicate your choice again.

4. You can make the game short or long by selecting any number of questions from 1 to 25.

5. You can request extra help from the computer if you incorrectly answer a question.

THE WATER CYCLE
(Background Information)

FACTS ABOUT EVAPORATION

I. 3 STATES OF WATER: Water is one of the unique materials on the earth's crust because it is able to exist in all 3 states of matter at the same time on the earth's surface: as solid ice, liquid, or gaseous water vapor.

II. EVAPORATION: The process of changing liquid water into water vapor.

III. ENERGY AND EVAPORATION: In order for evaporation of water to take place, heat energy is required. Evaporation occurs when enough heat energy is supplied to liquid water, causing the molecules to move faster and faster, until they have enough energy to escape from the other water molecules and move into the atmosphere as water vapor.

IV. WATER SOURCES OF EVAPORATION: The major sources of water for evaporation are:
- A. oceans
- B. lakes and ponds
- C. streams
- D. soil
- E. snow and ice (glaciers)

V. SUBLIMATION: Occurs when a solid evaporates directly into a gas, without first passing through the liquid state. Water undergoes sublimation when snow, frost, or ice evaporate by changing directly from the solid to the gaseous state.

VI. SATURATION: Occurs when the air contains the maximum amount of water vapor that it can hold.

VII. FACTORS AFFECTING THE RATE OF EVAPORATION:
- A. TEMPERATURE: The more heat energy available, the greater the amount of evaporation; so the higher the temperature, the greater the rate of evaporation.
- B. SURFACE AREA: The greater the surface area of the water, the greater its rate of evaporation.
- C. MOISTURE CONTENT OF THE AIR: The less water vapor already in the air, the greater the rate of evaporation.
- D. OTHER FACTORS: Air pressure, clouds in the sky, the amount of salt in the water.

VIII. EVAPORATION IS A COOLING PROCESS: When you come out of a pool or a shower, or when you are sweating, the heat energy to evaporate the water comes from your body, thereby lowering the temperature of your body.

FACTS ABOUT CONDENSATION

I. CONDENSATION: The process of changing gaseous water vapor into liquid water.

II. ENERGY AND CONDENSATION: Condensation is the exact opposite of evaporation, giving OFF heat energy, while evaporation takes IN heat energy.

III. HUMIDITY: Refers to the amount of water vapor in the air.

IV. CAPACITY OF AIR: The maximum amount of water vapor that the air can hold. The factor which determines the capacity of the air to hold water is temperature. The HIGHER the temperature, the GREATER the capacity of the air, while the LOWER the temperature, the LESSER the capacity of air to hold moisture.

V. SATURATION: Whenever the air is filled to capacity, it is said to be saturated. Saturation occurs when the rate of evaporation is equal to the rate of condensation.

VI. DEW POINT: The temperature at which condensation takes place.

A. To determine the dew point of air, take a metal can that is dry on the outside and add water until it is about 1/2 full. Place a thermometer into the water, add ice, and stir. Read the thermometer at the moment moisture appears on the side of the can. This is the dew point temperature.

B. The more water that evaporates into the air, the higher the dew point temperature will be.

VII. DEW AND FROST: DEW is water vapor that has condensed out of the air onto a cool surface. FROST is water vapor that has condensed, without first becoming liquid water. Frost is not frozen dew. Changing directly from the gaseous to the solid state is sublimation. Snow, as well as frost, forms by sublimation.

VIII. CONDENSATION NUCLEI: The particles on which water vapor IN THE AIR condense. The most common examples of condensation nuclei are dust, smoke, and salt from the oceans.

FACTS ABOUT THE WATER CYCLE

I. WATER (HYDROLOGIC) CYCLE: The name given to the continuous exchange of water between the land, the oceans, and the atmosphere. Since it is a cycle, discussion of it can begin anywhere, but evaporation is often taken as the starting point.

A. EVAPORATION: The water evaporates from the oceans, other water bodies, the soil, and ice caps and glaciers, as well as transpiring from vegetation.
B. MOVEMENT BY WINDS: Once in the air, the water vapor is moved about by the winds.
C. CONDENSATION: Eventually the water vapor condenses into clouds and fog.
D. PRECIPITATION: When water droplets grow large enough, they usually fall as rain or snow.
E. GROUNDWATER AND RUNOFF: Once on the earth's surface, the water either sinks into the ground and becomes part of the ground water supply or it runs along the surface as runoff.
F. RETURN TO OCEANS: Eventually the water returns to the oceans or large bodies of water, where the cycle starts to repeat itself.

II. TRANSPIRATION: The process by which water vapor enters the atmosphere from the leaves of plants. During the process of transpiration, water is drawn up from the soil through the roots of plants, where the water is stored and given off to the atmosphere through its leaves.

III. EVAPOTRANSPIRATION: A term that combines EVAPORATION of water from the earth's surface and TRANSPIRATION of water from plants. The greatest amount of evapotranspiration occurs near the equator, where there is considerable heat energy, while at the poles, there is very little heat energy and little evapotranspiration.

IV. PRECIPITATION: Condensed water which falls to the earth's surface. Its most common forms are rain and snow.

FOLLOW-UP QUESTIONS ABOUT EVAPORATION:

TRUE OR FALSE: Determine which of the following are true or false and, for each false statement, substitute for the capitalized word, the term which makes the statement correct.

1. Water can exist in THREE states of matter.
2. Evaporation is the process of changing liquid water into water in the SOLID state.
3. In order for evaporation to occur, HEAT energy is required.
4. The rate of evaporation increases as the moisture content of the air INCREASES.
5. Water evaporates most rapidly on days when the air is COLD, dry, and windy.
6. When water vapor enters the atmosphere, heat energy is ADDED to the water.
7. Evaporation is a HEATING process.
8. The major source of energy for the evaporation of water on the earth's surface is the SUN.
9. Dry ice and moth balls change from a solid to a gas by the process of SUBLIMATION.
10. When water evaporates from your skin, you feel COOL.

COMPLETION: Write in the word(s) which best complete each statement.

1. Water enters the atmosphere by a process called ( ).
2. The rate of evaporation can be increased by ( ) the surface area of a towel drying in a room.
3. The main source of water vapor for the atmosphere is the ( ).
4. The process of changing frost directly into water vapor is called ( ).
5. Increasing the temperature of water increases its rate of evaporation because it causes the molecules of water to move ( ).
6. When the air contains the maximum amount of water vapor that it can hold, ( ) occurs.
7. When you step out of a pool, the evaporation of water from your body will cause you to feel ( ).
8. Evaporation will occur (faster, slower, the same as) in air that is saturated with water vapor than in air that is not saturated.
9. Water in the gaseous state is called ( ).
10. On a rainy day, as compared with a clear day, the rate of evaporation will ( ).

THOUGHT QUESTIONS: Answer the questions below with simple statements.

1. Distinguish between the 3 different states of water.
2. Explain 2 conditions that will cause water to evaporate readily.
3. Differentiate between evaporation and sublimation.
4. How does increasing the temperature increase the rate of evaporation?
5. What are the main sources of water vapor for the atmosphere?

ANSWERS

TRUE OR FALSE

1. True
2. False, GASEOUS
3. True
4. False, DECREASES
5. False, HOT
6. True
7. False, COOLING
8. True
9. True
10. True

COMPLETION

1. evaporation (sublimation)
2. increasing
3. oceans
4. sublimation
5. faster
6. saturation
7. cool
8. slower
9. water vapor
10. decrease

THOUGHT QUESTIONS

1. In the solid state, it is ice; in the liquid state, it is water; and in the gaseous state, it is water vapor.
2. Any 2 of the following: An increase in temperature, an increase in the water's surface area, a decrease in the moisture content of the air, an increase in the amount of wind.
3. EVAPORATION involves liquid water changing to the gas water vapor, while SUBLIMATION occurs when solid water (snow or ice) changes directly into water vapor, without first passing through the liquid state.
4. Increasing the temperature of the water molecules causes them to move faster and faster, until they have enough energy to escape from the other water molecules at the water surface and move into the atmosphere as water vapor.
5. Oceans, lakes and ponds, rivers and streams, soil, and snow and ice.

FOLLOW-UP QUESTIONS ABOUT CONDENSATION:

TRUE OR FALSE: Determine which of the following are true or false and, for each false statement, substitute for the capitalized word, the term which makes the statement correct.

1. The process of changing water vapor to the liquid state is known as EVAPORATION.
2. The factor which determines the capacity of the air to hold water vapor is TEMPERATURE.
3. The lower the temperature, the GREATER the capacity of the air to hold moisture.
4. Saturation occurs when the rate of evaporation IS EQUAL to the rate of condensation.
5. When the air is SATURATED, there is a good chance of rain or snow.
6. The dew point is an indicator of the amount of MOISTURE in the air.
7. Frost IS frozen dew.
8. DEW forms by the process of sublimation.
9. When water vapor in the air begins to condense, the TEMPERATURE of the air is at the dew point.
10. Water ENTERS the air by the process of condensation.

COMPLETION: Write in the word(s) which best complete each statement.

1. The maximum amount of water vapor that the air can hold is known as the ( ) of the atmosphere.
2. During the process of evaporation, heat energy is (released, absorbed), while during the process of condensation, heat energy is ( ).
3. Whenever the air is filled to capacity, it is said to be ( ).
4. The temperature at which condensation takes place is known as the ( ).
5. The term which explains both the changing of water vapor directly to the solid state and the solid state directly to water vapor is ( ).
6. The particles on which water vapor in the air condense are known as ( ).
7. The amount of moisture in the air is generally referred to as the ( ) of the air.
8. Moisture in the air that condenses on solid surfaces (grass, for example) is called ( ).
9. As the temperature of the air increases, its capacity to hold water vapor ( ).
10. Good examples of condensation nuclei are ( ), ( ), and ( ).

THOUGHT QUESTIONS: Answer the questions below with simple statements.

1. What is the difference between the terms, CAPACITY and SATURATION?
2. The outside of a glass of cold soda often becomes covered with beads of water. How can this be explained?
3. When would a pitcher of cold soda NOT become covered with beads of water?
4. What is the difference between dew and frost?
5. Describe the process of condensation in terms of heat energy.

ANSWERS

TRUE OR FALSE

1. False, CONDENSATION
2. True
3. False, LESSER
4. True
5. True
6. True
7. False, IS NOT
8. False, FROST (SNOW)
9. True
10. False, LEAVES

COMPLETION

1. capacity
2. absorbed, released
3. saturated
4. dew point
5. sublimation
6. condensation nuclei
7. humidity
8. dew
9. increases
10. dust, smoke, salt

THOUGHT QUESTIONS

1. CAPACITY is the maximum amount of water vapor that the air can hold, while SATURATION is the term used when the air is filled to capacity.
2. The cold soda cools the glass, which in turn cools the air in contact with the glass to the dew point, and condensation occurs.
3. No beads will form if the air can't be cooled down to the dew point.
4. DEW is moisture on a surface that comes out of the air near the surface on which it condenses, while FROST is water vapor that has condensed to the solid state, without first becoming liquid water.
5. Condensation involves the release of heat energy as water vapor changes to the liquid state. It is the opposite of evaporation.

FOLLOW-UP QUESTIONS ABOUT THE WATER CYCLE:

TRUE OR FALSE: Determine which of the following are true or false and, for each false statement, substitute for the capitalized word, the word which makes the statement correct.

1. Water vapor is moved about in the atmosphere by the WINDS.
2. In the water cycle, water returns to the earth's surface by TRANSPIRATION.
3. Another name for the water cycle is the HYDROLOGIC CYCLE.
4. The major source of water vapor for evaporation is LAKES.
5. Even VOLCANOES provide water to the atmosphere during their active periods.
6. The term that combines both evaporation and transpiration is EVAPOTRANSPIRATION.
7. Snow and ice supply water vapor to the atmosphere through the process of PRECIPITATION.
8. Most precipitation DOES take place where it evaporates.
9. The water vapor content of the air is usually highest over the DESERTS.
10. When water vapor condenses into clouds, heat energy is RELEASED.

COMPLETION: Write in the word(s) which best complete each statement.

1. Water vapor enters the atmosphere by the process of ( ).
2. In the atmosphere, water vapor changes back into liquid water through the process of ( ).
3. The process by which water vapor enters the atmosphere from the leaves of plants is called ( ).
4. The name given to the continuous exchange of water between the land, the ocean, and the atmosphere is the ( ).
5. The major source of heat energy for evaporation of water is the ( ).
6. Of the earth's total water supply, about ( )% is oceans, while the remaining ( )% is fresh water.
7. Following a heavy rain, water that sinks into the ground becomes ( ), while water that flows along the surface is called ( ).
8. The major forms of precipitation are ( ) and ( ).
9. The greatest amount of evapotranspiration occurs at the ( ), and the least occurs at the ( ).
10. The main energy source of all weather is the ( ) carried by the water vapor through the atmosphere.

THOUGHT QUESTIONS: Answer the questions below with simple statements.

1. Summarize the steps of the water cycle.
2. Explain the role of plants as a source of water vapor to the atmosphere.
3. List as many sources of water vapor as you can for evaporation into the atmosphere during the water cycle.
4. Distinguish between the processes of evaporation and transpiration.
5. List 4 forms of precipitation.

ANSWERS

TRUE OR FALSE

1. True
2. False, PRECIPITATION
3. True
4. False, OCEANS
5. True
6. True
7. False, SUBLIMATION
8. False, DOES NOT
9. False, OCEANS
10. True

COMPLETION

1. evaporation (sublimation, transpiration, evapotranspiration)
2. condensation
3. transpiration
4. water cycle
5. sun
6. 96.7, 3.3
7. ground water, runoff
8. rain, snow
9. equator, poles
10. heat energy

THOUGHT QUESTIONS

1. Evaporation, wind movement, condensation, precipitation, runoff, and ground water.
2. Through the process of TRANSPIRATION, the roots draw water from the soil, and the water is carried to the leaves and given off into the atmosphere.
3. Oceans, plants (transpiration), lakes, ponds, streams, marshes, soil, burning fuels, volcanoes, snow caps, glaciers.
4. EVAPORATION is the process of changing liquid water into water vapor. TRANSPIRATION is the process by which water vapor enters the atmosphere through the leaves of plants.
5. Rain, snow, hail, sleet.

TESTS YOUR STUDENTS' KNOWLEDGE OF:

A. The meaning of the terms, "humidity," and its significance
B. The relationship between temperature and the air's capacity
C. The use of a table of "The Amount of Water Vapor in Saturated Air"
D. The formula for calculating relative humidity
E. How the human body senses humidity
F. The use of the sling psychrometer in determining relative humidity
G. How the data collected with a sling psychrometer can be used in conjunction with a TABLE OF DRY-BULB THERMOMETER READINGS VS. DIFFERENCE BETWEEN WET- AND DRY-BULB THERMOMETER READINGS
H. General relationships between temperature and humidity

SYNOPSIS OF THE GAME:

The game of HUMIDITY involves an auto race, in which the student can either race against the computer (one-player version) or another student (two-player version).

The object of the game is, of course, to cross the finish line first and receive a "trophy." Each time a question is answered correctly, the car advances towards the finish-line. An incorrect answer results in no advance.

Any time that an incorrect answer is given to a question, the computer will ask your students if they want some extra help. If the answer is "yes," the students are provided with one or more screens of information about humidity.

The computer will also analyze the race and keep the players informed of how the race is going.

WATER & WEATHER ------ HUMIDITY

EXTRA HELP SECTION OF THE PROGRAM:

SCREEN 1: SOME IMPORTANT FACTS ABOUT HUMIDITY

1. Entering the atmosphere from evaporation, water vapor makes up only a small portion of the tmosphere, but is the most important ingredient when weather and climate are considered.
   when considering the weather and climate. It enters the atmosphere from evaporation.
2. Humidity is related to the amount of water vapor in the air.
3. When the air temperature and dew point temperature (both measured in degrees) are very close, the relative humidity is near 100%, and precipitation is likely.

SCREEN 2: SOME IMPORTANT DEFINITIONS

CAPACITY: The amount of water vapor the air can hold at a particular temperature
SATURATED: When the air is filled to capacity, it is said to be saturated
DEW POINT: The temperature at which condensation takes place

SCREEN 3: WHAT IS RELATIVE HUMIDITY?

Relative humidity represents the amount of water vapor actually in the air compared to the amount of water vapor the air can hold at that temperature.

Relative Humidity = (Amt. of Water Vapor in Air divided by the Capacity of Air) times 100

SCREEN 4: WAYS OF MEASURING HUMIDITY

1. COBALT CHLORIDE: Detects moisture in the air.
   A. It is BLUE when the air is DRY.
   B. It is PINK when the air is HUMID.

2. HAIR: People with naturally curly hair have a built-in humidity indicator:
   A. If their hair becomes CURLY, the humidity is HIGH.
   B. If their hair is rather STRAIGHT, the humidity is LOW.
   C. Blonde hair reacts more to humidity than does dark hair.

3. SLING PSYCHROMETER: An instrument used together with a table of THE AMOUNT OF WATER IN SATURATED AIR.

SCREEN 5: THE SLING PSYCHROMETER

1. This device contains 2 thermometers; one is called a dry-bulb thermometer, while the other, with a cloth covering around the bulb (a wick) is called a wet-bulb thermometer.
2. To use the psychrometer...
   A. Wet the wick and squeeze excess water.
   B. Spin the psychrometer until both temperatures stop changing.
   C. Read the temperature.
3. Swinging the psychrometer speeds up the rate of evaporation by removing water from the wick more quickly. Saturated air from the area surrounding the wet-bulb is cleared.
4. If the air is DRY, then a GREAT DEAL of water will evaporate from the wick. This causes the temperature of the wet-bulb to DECREASE quite a bit compared to the dry-bulb.
5. If the air is HUMID, evaporation from the wick will occur SLOWLY and the wet-bulb temperature will be almost the SAME as the dry bulb temperature.
6. If the humidity is 100%, evaporation from the wet-bulb thermometer will not take place and both thermometers will have the same reading.

SCREEN 6: HOW HUMIDITY VARIES

1. The amount of water vapor in the air changes from day to day.
2. The amount of water vapor in the air changes with TEMPERATURE.
3. Humidity is HIGHEST in regions with plenty of SUNLIGHT and where WATER VAPOR is available.
4. Humidity is LOWEST in regions which have LITTLE WATER VAPOR available.

SCREEN 7: HUMIDITY AFFECTS HOW YOU FEEL

1. Evaporation is a cooling process. On humid days, sweat evaporates more slowly from your body than on dry days. This leaves you feeling more uncomfortable.
2. People who suffer from arthritis and other joint diseases often claim to feel the humidity in their joints, causing them pain.
3. An air conditioner can help to remove moisture from a room.

SCREEN 8: TEMPERATURE AND HUMIDITY

The WARMER the air, the MORE water vapor it can hold. This can be seen on a table of THE AMOUNT OF WATER VAPOR IN SATURATED AIR.

Then go to THE AMOUNT OF WATER VAPOR IN SATURATED AIR TABLE

SCREEN 9: TO USE A RELATIVE HUMIDITY TABLE:

1. Look up the dry-bulb temperature (vertical column).
2. Calculate the difference between the dry - and wet-bulb temperatures (horizontal column).
3. Where the 2 columns meet is the humidity.

A relative humidity table appears as part of the extra help.

WATER & WEATHER ------ HUMIDITY

HINTS FOR THE TEACHER:

1. This program can be used as a follow-up to our sound filmstrip programs entitled:
   A. HUMIDITY: THE DEGREE OF MOISTURE
   B. HUMIDITY: MEASUREMENT AND APPLICATIONS
   Both filmstrips are part of the series: WATER IN THE AIR.
2. All questions are multiple-choice.
3. There are 40 different questions available in this game. The competing students will each receive different questions. Ten correct answers are required for a student to cross the finish line.
4. Two tables, that appear on the computer screen when needed, are also provided in this section:
   A. The Amount of Water Vapor in Saturated Air
   B. Relative Humidity
   If you prefer, you can duplicate these tables so that your students may use them with this program.
5. Students can be encouraged to compete against each other or the computer. If they elect to challenge the computer, they must get more than 75% of the answers correct (on the average) to beat the computer.

HINTS FOR THE STUDENT:

1. The game portion of this program involves an auto race. You advance towards the finish line by answering questions correctly about HUMIDITY.
2. Whenever a YES or NO response is requested, you need only type the letters Y or N.
3. You can either compete against a fellow student or against the computer. If you choose to race against the computer, you most average better than 75% of the questions correct to be able to beat the computer.
4. When you are asked to select an answer to a question, only the NUMBER of the choice should be typed. Any other response will result in the (computer's) asking you to indicate your choice again.
5. You can request extra help from the computer if you incorrectly answer a question.

HUMIDITY (Background Information)

I. COBALT CHLORIDE PAPER: Can serve as an indicator of moisture in the air. BLUE means DRY weather, while PINK refers to a HIGH HUMIDITY.

II. TABLE OF THE AMOUNT OF WATER VAPOR IN SATURATED AIR: This table shows the actual amount of water vapor the air can hold at various temperatures. For example, according to the table, at 16 degrees C, the air can hold 13.0 grams of water vapor per cubic meter of air.

III. The WARMER the air, the MORE water vapor it can hold. The COLDER the air, the LESS water vapor it can hold.

IV. RELATIVE HUMIDITY: THe amount of water vapor actually in the air compared to the maximum amount of water vapor the air can hold at that temperature.

V. To find the relative humidity, this formula can be used:

$$\text{Relative Humidity} = \frac{\text{Amount of Water Vapor in Air}}{\text{Capacity of Air}} \times 100$$

EXAMPLE: Determine the relative humidity of the air if the temperature is 20 degrees C and the amount of water vapor actually in the air is 9.1 g/(m to the 3rd power). The Table of The Amount of Water Vapor in Saturated Air shows the capacity of the air to be 18.2 g/(m to the 3rd power) of water vapor. Substituting these values into the formula, you get:

$$\text{Relative Humidity} = \frac{9.1 \text{ g/(m to the 3rd)}}{18.2 \text{ g/(m to the 3rd)}} \times 100 = 50\%$$

VI. RELATIVE HUMIDITY AND DEW POINT: Relative humidity can also be determined by knowing the temperature and experimentally determining the dew point. (The dew point temperature is actually an indicator of the number of grams of water vapor per cubic meter of air).

EXAMPLE: Given: Actual outdoor temperature: 26 degrees C
Dew point temperature: 10 degrees C

At 26 degrees C, the capacity of air is 23.5 g/(m to the 3rd) (See Table). At a dew point of 10 degrees C, the amount of moisture actually in the air is 9.3 g/(m to the 3rd). (See Table).

$$\text{Relative Humidity} = \frac{9.3 \text{ g/(m to the 3rd)}}{23.5 \text{ g/(m to the 3rd)}} \times 100 = 39.6\%$$

VII. HAIR AND HUMIDITY RELATIONSHIPS: On dry days, naturally curly hair will be relatively straight, while on humid days, it will tend to be curly. Blonde hair tends to react more to humidity than does brown hair.

VIII. THE SLING PSYCHROMETER: An instrument used to help measure the relative humidity of the air. It consists of a dry-bulb thermometer and a wet-bulb thermometer. To use a sling psychrometer, wet the wick on the wet-bulb thermometer, spin it around until both temperatures stop changing, and read the temperatures. The dry-bulb thermometer shows the air temperature, while the wet-bulb thermometer indicates how easily water can evaporate into the air. When the air is relatively dry, the wet- and dry- bulb temperatures are far apart. When the air is relatively humid, the wet- and dry-bulb temperatures are close together.

IX. THE SLING PSYCHROMETER AND RELATIVE HUMIDITY: A chart has been developed which compares the wet- and dry-bulb temperatures to determine the relative humidity. In the left vertical column of the chart are the dry-bulb temperatures, while the horizontal column, along the top, represents the difference between the wet- and dry-bulb thermometer readings. To use this chart, first determine the wet- and dry-bulb temperatures experimentally, with a sling psychrometer.
For example: Assume a dry-bulb temperature of 20 degrees C and a wet-bulb temperature of 14 degrees C.
   A. Find the dry-bulb temperature (20 degrees C) in the vertical column at the left.
   B. Now take the DIFFERENCE between the two readings (dry- and wet-bulb), 20 degrees - 14 degrees = 6 degrees.
   C. Locate 6 degrees C in the horizontal column at the top.
   D. Where the two columns meet, the relative humidity is shown (in this case, 51%).

X. TEMPERATURE, MOISTURE CONTENT, AND RELATIVE HUMIDITY:
   A. If the temperature decreases while the amount of moisture remains the same, the relative humidity will increase and vice versa.
   B. If the amount of moisture increases while the temperature remains constant, the relative humidity increases and vice versa.

XI. HUMIDITY CONTROL: Methods include:
   A. air conditioners - cool and remove moisture
   B. dehumidifiers - remove moisture
   C. humidifiers - add moisture

FOLLOW-UP QUESTIONS ABOUT HUMIDITY

TRUE OR FALSE: Determine which of the following are true or false and, for each false statement, substitute for the capitalized word(s), the term(s) which make the statement correct.

1. Although only a small part of the atmosphere, the most important ingredient when considering humid weather and climate is DUST.
2. There is USUALLY water vapor in the air.
3. The air is limited in the amount of water vapor that it can hold by the WIND SPEED.
4. The capacity of the air is the MINIMUM amount of water vapor that it can hold.
5. The amount of water vapor in the air can be stated in G/M TO THE 3RD POWER.
6. The temperature to which air must be cooled to give condensation is called its DEW POINT.

NOTE: FOR QUESTIONS 7-10 USE THE TABLE: THE AMOUNT OF WATER VAPOR IN SATURATED AIR

7. At 14 degrees C, the air can hold FOURTEEN g/(m to the 3rd) of water vapor.
8. If the dew point is 20 degrees C, the air actually contains EIGHTEEN. TWO g/(m to the 3rd) of water vapor.
9. According to the table, the warmer the air, the LESS water vapor the air can hold.
10. If the amount of moisture in the air is 8.1 g/(m to the 3rd), and the temperature is 10 degrees C, the air IS saturated.
11. People with certain diseases can use their aches and pains to help predict HUMID weather conditions.
12. Blonde hair is a POORER indicator of moisture than is brown hair.
13. An instrument used to help measure the relative humidity of the air is a THERMOMETER.
14. The wet-bulb thermometer indicates the amount of moisture in the air by its ability to ABSORB water from the wick.
15. If the air is humid, the difference between the wet- and dry-bulb temperatures will be GREAT.
16. If the moisture content of the air stays the same and the temperature increases, the relative humidity will DECREASE.
17. When the relative humidity is highest, the temperature is LOWEST.
18. To eliminate the humidity in a room, a HUMIDIFIER is used.
19. As the air becomes more humid, the difference between the wet- and dry-bulb temperatures of a sling psychrometer will DECREASE.
20. The relative humidity of the air is usually MORE than 100%.

WATER & WEATHER ------ HUMIDITY

COMPLETION: Write in the word(s) which best complete each statement.

1. The amount of water vapor in the air can be indicated by paper treated with the chemical, cobalt chloride. If the color of the paper is blue, the air is ( ).
2. The amount of water vapor actually in the air compared to the maximum amount of water vapor the air can hold at that temperature is the definition for ( ).
3. When the air is filled to capacity, it is said to be ( ).
4. The formula for determining the relative humidity of the air is ( ).
5. The number of grams of water vapor per cubic meter actually in the air is indicated by the ( ) temperature.

NOTE: FOR QUESTIONS 6-10, USE THE TABLE: THE AMOUNT OF WATER VAPOR IN SATURATED AIR

6. If the temperature is 24 degrees C, the water vapor capacity of the air is ( )g/(m to the 3rd).
7. If the dew point temperature is 6 degrees C, the actual amount of water vapor in the air is ( )g/(m to the 3rd).
8. The capacity of the air at 16 degrees C is twice the capacity of the air at a temperature of about ( ) degrees C.
9. If the temperature of the air is 16 degrees C and the dew point temperature is 8 degrees C, saturation would take place if the temperature fell or the dew point temperature ( ).
10. Which has a higher dew point temperature: air that contains 7.5 g/(m to the 3rd) of water vapor or air that contains 19.4 g/(m to the 3rd)? ( ) What is the dew point temperature of the air with the higher dew point? ( )
11. The relative humidity of a certain body of air is 100% If this air is cooled, the water vapor will begin to ( ).
12. Wet-bulb temperatures vary according to the air's ability to evaporate water vapor. When a great deal of water evaporates from the wick, the wet-bulb temperature drops. This happens because evaporation is a ( ) process.
13. A device that can add humidity to a room is called a ( ).
14. Any time the wet- and dry-bulb temperatures on a sling psychrometer are the same, the relative humidity must be ( )%.
15. To increase the rate of evaporation from the wick of a wet-bulb thermometer, the sling psychrometer is ( ) in the air.
16. When the wet- and dry-bulb temperatures are the same, ( ) usually occurs.
17. Swinging a wet-bulb thermometer around speeds up the ( ) process by removing water from the wick.

NOTE: FOR QUESTIONS 18-20, USE THE CHART TO HELP YOU.

18. Dallas, Texas has an air temperature of 26 degrees C and a difference of 14 degrees C between the wet- and dry-bulb temperatures. The relative humidity in Dallas is ( )%.
19. If the dry-bulb of a sling psychrometer reads 24 degrees C, and the wet-bulb reads 13 degrees C, the relative humidity of that air is ( )%.
20. If you are in Boston, Massachusetts and the dry-bulb temperature is 15 degrees C, with the wet-bulb temperature 14 degrees C, the relative humidity is ( )%.

THOUGHT QUESTIONS: Answer the questions with simple statements. For questions 3-5, you will need the table: The Amount of Water Vapor in Saturated Air. Use the Relative Humidity chart for questions 9 and 10.

1. If the temperature of the air in the Mojave Desert is 26 degrees C with a dew point temperature of 6 degrees C, while the temperature of Albany, New York is 16 degrees C with a dew point of 6 degrees C, which location has the greater amount of water vapor in the air? Why?
2. What effect does increasing the temperature of a sample of air have on each of the following: (a) amount of moisture in the air, (b) the level of saturation, and (c) the relative humidity.
3. If the temperature of the air where you live is 24 degrees C, and the amount of moisture in the air is 10.5 g/(m to the 3rd), what is the relative humidity?
4. If the dew point temperature in a certain location is 20 degrees C, and the air temperature there is 26 degrees C, what is the relative humidity in that location?
5. Which of the following locations has the higher relative humidity: the Mojave Desert (temperature: 32 degrees C and dew point: 12 degrees C) or the Arctic Circle (temperature: 8 degrees C and dew point: 4 degrees C)?
6. State the 2 factors which determine the relative humidity of the air.
7. Why does the relative humidity of the air increase as the temperature falls, even though the amount of moisture in the air remains unchanged?
8. Why do the wet- and dry-bulb temperatures on a sling psychrometer usually differ?
9. What is the relative humidity on a day when the dry-bulb temperature of a sling psychrometer is 16 degrees C, and the wet-bulb reading is 12 degrees C?
10. Which of the following locations has a higher relative humidity: Seattle, Washington with a dry-bulb temperature of 12 degrees C and a wet-bulb reading of 7 degrees C, or Miami, Florida, with a dry-bulb reading of 23 degrees C, and a wet-bulb reading of 18 degrees C?

ANSWERS

TRUE OR FALSE

1. False, WATER VAPOR (moisture)
2. True
3. False, TEMPERATURE
4. False, MAXIMUM
5. True
6. True
7. False, 11.4
8. True
9. False, MORE
10. False, IS NOT
11. True
12. False, BETTER
13. False, SLING PSYCHROMETER
14. False, EVAPORATE
15. False, SMALL
16. True
17. True
18. False, DEHUMIDIFIER
19. True
20. False, LESS

COMPLETION

1. dry
2. relative humidity
3. saturated
4. $$R.H. = \frac{\text{Amt. Moisture in Air}}{\text{Capacity of Air}} \times 100$$
5. dew point
6. 22.0
7. 7.5
8. 4
9. rose
10. 19.4, 22
11. condense
12. cooling
13. humidifier
14. 100
15. spun
16. precipitation
17. evaporation
18. 14
19. 26
20. 90

THOUGHT QUESTIONS

1. They both have the same, because the dew point, an indicator of the amount of water vapor in the air, is the same at both locations.
2. (a) no effect on the amount of moisture, (b) the saturation level goes down, (c) the relative humidity goes down.
3. $$\text{Relative Humidity} = \frac{\text{Amount of Water Vapor in Air}}{\text{Capacity of Air}} \times 100$$
$$= \frac{10.5 \text{ g/(m to the 3rd)}}{22.0 \text{ g/(m to the 3rd)}} \times 100 = 45.5\%$$
4. If dew point is 20 degrees C, actual amount of water vapor in the air is 18.2 g/(m to the 3rd) (according to the Table). At 26 degrees C, the air can hold 23. 5 g/(m to the 3rd) water vapor
$$\text{Relative Humidity} = \frac{18.2 \text{ g/(m to the 3rd)}}{23.5 \text{ g/(m to the 3rd)}} \times 100 = 77.5\%$$
5. The relative humidity is higher in the ARCTIC CIRCLE.
MOJAVE DESERT:
$$\text{Relative Humidity} = \frac{10.7 \text{ g/(m to the 3rd)}}{34.0 \text{ g/(m to the 3rd)}} \times 100 = 31.5\%$$
ARCTIC CIRCLE:
$$\text{Relative Humidity} = \frac{6.4 \text{ g/(m to the 3rd)}}{8.1 \text{ g/(m to the 3rd)}} \times 100 = 79\%$$
6. (1) the amount of moisture in the air, and (2) the air temperature.
7. Relative humidity is the amount of water vapor actually in the air compared to the maximum amount of water vapor the air can hold (the capacity) at that temperature. When the temperature falls, the capacity of the air decreases. Thus, when you compare the amount of water vapor in the air to the capacity, you find the relative humidity increases.
8. Because the air is usually not saturated. The wet-bulb temperature is lower than the dry-bulb temperature because water evaporates from its wick taking heat away from the bulb.
9. Dry-bulb reading: 16 degrees C
Difference: 16 degrees C - 12 degrees C = 4 degrees C
Relative Humidity = 63%
10. Miami, Florida has a higher relative humidity. The relative humidity there is 62%, while in Seattle, Washington, it is only 48%.

TESTS YOUR STUDENTS' KNOWLEDGE OF:

A. What clouds are
B. How clouds form
C. The differences among the high, middle, low, and vertical development clouds and the members of each family
D. How clouds can sometimes be used to predict the weather
E. The two main theories of precipitation formation: the coalescence process and the ice crystal process
F. The various forms of precipitation: drizzle, rain, snow, sleet, and hail

SYNOPSIS OF THE GAME:

There is a game board with three categories: CLOUDS, PRECIPITATION, and POT LUCK. (POT LUCK contains questions about either "clouds" or "precipitation.") Each category has three different amounts of money the student can "wager:" $25, $50, or $100.

The computer will then ask the student how many questions are to be played. After responding, the student is given $200 and told to select a category and a dollar amount to bet. A multiple-choice question is then asked. A correct answer adds the wagered dollar value to the student's money, while an incorrect answer subtracts the money. The game board will continually let your student know how many questions remain and how much money he has.

Any time that an incorrect response is given to a question, the computer will ask your student, "Would you like some extra help?" If the answer is "yes," several screens of information about clouds and precipitation are provided.

The game ends when the number of questions selected by the student have been answered. At that point, a check appears on the screen, written out to the student for the total amount of money accumulated at the end of the game. In the event that the student loses all the money before the game ends, the computer will offer some extra help and then end the game.

WATER & WEATHER ------ CLOUDS AND PRECIPITATION

EXTRA HELP SECTION OF THE PROGRAM:

The following extra help screens of information are available and will be furnished when requested. Screens appropriate to the questions missed will appear.

SCREEN #1: SOME IMPORTANT DEFINITIONS

PRECIPITATION: Any water droplets or ice particles that fall to the earth's surface from clouds
SUPERCOOLED: Liquid water below its freezing point
EVAPORATION: Process of liquid water changing into water vapor
CONDENSATION: Process of water vapor changing into liquid water
SUBLIMATION: Process of solid water changing into water vapor
METEOROLOGY: The branch of science that studies the atmosphere
CLOUDS: Tiny droplets of water or ice crystals suspended in the air
DEW POINT: Temperature at which condensation takes place

SCREEN #2: SOME FACTS ABOUT CLOUDS

1. Clouds can be thought of as INDICATORS of the weather.
2. About one million raindrops are equal in size to one cloud droplet.
3. Ultraviolet radiation can pass through clouds and give you a nasty sunburn.
4. The best type of condensation nuclei for cloud formation are ice crystals.
5. Clouds tend to form in the troposphere (reaches altitude of about 12 km).

SCREEN #3: HOW CLOUDS ARE FORMED

1. Clouds form when:
   A. Water EVAPORATES from the earth's surface.
   B. The moist air RISES. (See 2 below)
   C. The moist air cools to the DEW POINT.
   D. The moist air condenses on CONDENSATION NUCLEI.
2. Four ways that moist air can rise:
   A. Air expands when heated by the sun, becomes lighter, and rises.
   B. Cold air moves across the land and pushes up warmer lighter air in front of it.
   C. Warm air moves over the land faster than cold air. THe lighter, warmer air is forced to move over heavier, colder air.
   D. Moving air pushes against a barrier, such as a mountain, and rises over the barrier.

SCREEN #4: GENERAL TYPES OF CLOUDS

TYPE	ALTITUDE	EXAMPLES
High	Above 6 km	cirrus cirrostratus cirrocumulus
Middle	Between 2 and 6 km	altostratus altocumulus
Low	Below 2 km	stratus nimbostratus stratocumulus
Vertical Development	From 100 m to over 10 km	cumulus cumulonimbus

SCREEN #5: HIGH CLOUDS

CIRRUS:
- A. Thin, white, delicate, wispy clouds made of tiny ice crystals
- B. Usually fair weather clouds
- C. Often indicate approach of a warm front

CIRROSTRATUS:
- A. Thin sheet of white ice-crystal clouds that may give the sky a milky look
- B. Cirrus followed by cirrostratus in a warm front, indicates that precipitation is 12-48 hours away

CIRROCUMULUS: Thin, white, ice-crystal clouds of small white puffs

SCREEN #6: MIDDLE CLOUDS

ALTOSTRATUS:
- A. Thick, gray, sheet-like clouds; often fibrous
- B. If cirrus and cirrostratus are followed by altostratus during a warm front, a long period of precipitation will probably soon follow.

ALTOCUMULUS:
- A. White, patchy clouds, commonly resembling cotton balls
- B. Generally not associated with precipitation
- C. Made of water

SCREEN #7: LOW CLOUDS

STRATUS:
- A. Low, sheet-like clouds covering large parts of the sky
- B. Often block out sun and fill the air with mist

NIMBOSTRATUS: A dark, layered cloud that produces rain or snow

STRATOCUMULUS:
- A. Consist of layers of large puffy patches. They tend to accompany gusty, windy conditions.
- B. Sunlight is able to pass through breaks in these clouds, keeping the day bright.

SCREEN #8: VERTICAL DEVELOPMENT CLOUDS

CUMULUS:
- A. Thick with a puffy "cauliflower" appearance and very flat bases
- B. Constantly changing shape
- C. Often called "fair-weather clouds"

CUMULONIMBUS:
- A. Heavy, towering clouds with dark, flat bases
- B. Produce lightning and thunder with rain
- C. Have violent motions within and can be quite dangerous
- D. Commonly found at the leading edge of cold fronts

SCREEN #9: SOME FACTS ABOUT PRECIPITATION

1. Precipitation occurs when water changes into water vapor, is moved somewhere else, cools and condenses on condensation nuclei (usually smoke, dust, pollen or salt). Water droplets then grow larger and larger until they fall.
2. Glaze is not a form of precipitation. It forms when rain hits the ground or some other surface and instantly freezes.
3. One centimeter of rain is equal to aout 10 centimeters of snow.
4. Cloud seeding is an attempt by man to produce rain. One of the best nuclei used in cloud seeding is silver iodide.

SCREEN #10: HOW PRECIPITATION FORMS

COALESCENCE PROCESS:

Larger cloud droplets fall, and combine with many smaller droplets along the way until they are large enough to fall to the ground as raindrops.

ICE-CRYSTAL PROCESS:

Certain clouds have some ice crystals in their upper parts among the supercooled water droplets. These ice crystals act as "freezing nuclei" and are the best type of nuclei. Some of the supercooled water droplets evaporate, forming water vapor. The water vapor then condenses onto each ice crystal causing it to grow larger and heavier. As they fall, they pick up other water droplets and grow by the coalescence process until they fall as precipitation.

SCREEN #11: TYPES OF PRECIPITATION

DRIZZLE: Fine droplets of rain fallling from low stratus clouds. This is the smallest form of precipitation.
HAIL: Particles of ice which usually fall from summertime cumulonimbus clouds
SLEET: Rain which freezes before it hits the ground
SNOW: 6-sided ice crystals which form by sublimation below 0 degrees C. If temperatures begin to rise as the snow falls, it becomes wet snow.
VIRGA: A type of rain which evaporates before it reaches the ground

WATER & WEATHER ------ CLOUDS AND PRECIPITATION

HINTS FOR THE TEACHER:

1. This program can be used as a follow-up to our sound filmstrip series entitled, "CLOUDS AND PRECIPITATION." (For more information, see back of this Teacher's Lesson Planner).

2. All questions are multiple choice.

3. The program has been designed so that no question will be repeated within a category until all questions for that dollar amount have been used up. There are 45 questions in all (5 for each category and dollar amount).

4. If you want to use this game to its fullest extent, suggest to your students that they play each category and dollar amount at least once during the game.

5. You can encourage competition among your students by seeing who can win the most money by attempting to answer the same number of questions.

HINTS FOR THE STUDENT:

1. This program involves a game board in which you can wager money and test your knowledge on the subject of CLOUDS AND PRECIPITATION.

2. When asked to select a category, you should type in only the indicated letters: C for CLOUDS, P for PRECIPITATION and L for POT LUCK. (Pot Luck contains questions on both clouds and precipitation). If any other response is given, the computer will ask you to choose again.

3. When asked for the dollar value of your question, you can type in only the numbers 25, 50, or 100 (NO $ sign). Any other response will result in the statement, "invalid bet," from the computer.

4. When you are asked to select an answer to a question, only the NUMBER of the choice should be given. Any other response will result in the computer's asking you to indicate your response again.

5. You can request extra help from the computer if you incorrectly answer a question.

CLOUDS AND PRECIPITATION
(Background Information)

FACTS ABOUT CLOUDS:

I. NEW VOCABULARY

Clouds
Meteorologist
Troposphere
Fog

II. DEFINITIONS

A. CLOUDS: Tiny droplets of water or ice crystals suspended in air
B. METEOROLOGIST: A professional weather observer
C. TROPOSPHERE: The layer of the atmosphere starting at the earth's surface and reaching to an altitude of about 12 km (40,000 ft.)

D. FOG: A cloud resting on the surface of the ground

III. HOW CLOUDS FORM:

Clouds form when water leaves the Earth's surface by either evaporation or transpiration. Then, the moist air rises, cools to the dew point, and condenses on condensation nuclei.

IV. CONDITIONS FOR CLOUD FORMATION:

The way in which moist air rises can vary.

A. The sun can heat the air, causing the air to expand, become lighter, and rise.
B. Cold, heavy air can move over the land like a plow, pushing up the warm air in front to it. This results in a cold front.
C. Warm air can move over the land faster than cold air. The lighter, warmer air is forced to move over the heavier, colder air, resulting in a warm front.
D. Moving air can push against a barrier, such as a mountain, and has no choice but to rise over the mountain to keep moving.

V. CLOUD FAMILIES:

There are four basic families of clouds that are grouped on the basis of their altitude.

A. HIGH CLOUDS: above 6 km (20,000 ft.)
B. MIDDLE CLOUDS: 2-6 km (6,500 - 20,000 ft.)
C. LOW CLOUDS: below 2 km (6,500 ft.)
D. VERTICAL DEVELOPMENT CLOUDS: From 100 meters (300 ft.) to over 10 km (3,000 ft.)

VI. CLOUD TYPES:

A. HIGH CLOUDS:

1. CIRRUS: Thin, white, delicate, wispy clouds made of tiny ice crystals
2. CIRROSTRATUS: A thin sheet of white ice-crystal clouds that may give the sky a milky look. When in front of the sun or moon, they create large rings or halos around them. When cirrostratus clouds follow cirrus clouds in the sky, a warm front may be on the way, followed by precipitation in 2 - 3 days.
3. CIRROCUMULUS: Thin, white, ice-crystal clouds of small white puffs

B. MIDDLE CLOUDS:

1. ALTOSTRATUS: Thick, gray, sheet-like clouds. When altostratus clouds follow cirrus and cirrostratus clouds, the warm front is very near, and there is a good chance of precipitation in just a few hours.
2. ALTOCUMULUS: White, patchy clouds, commonly resembling cotton balls. These clouds are generally associated with fair weather.

C. LOW CLOUDS:

1. STRATUS: Low, sheet-like clouds covering large parts of the sky. Most rain clouds start off as stratus clouds.
2. NIMBOSTRATUS: Dark, layered clouds that produce rain or snow. In a warm front, precipitation can fall from these clouds for about 6 to 18 hours.
3. STRATOCUMULUS: A layer of large puffy patches

D. VERTICAL DEVELOPMENT CLOUDS:

1. CUMULUS: Thick with a puffy cauliflower appearance and very flat bases. They are often called "fair weather" clouds.
2. CUMULONIMBUS: Heavy, towering clouds with dark, flat bases. They often produce lightning and thunder along with rain. They may sometimes have a beautiful flat anvil shape at the top. These clouds are often found at the leading edge of a "cold front."

VII. FOG: A cloud resting on the surface of the ground. Fog occurs when the air near the ground cools to the dew point and condenses.

FACTS ABOUT PRECIPITATION:

I. NEW VOCABULARY

precipitation	snow
supercooled	blizzard
drizzle	sleet
rain	glaze
virga	hail

II. DEFINITIONS:

A. PRECIPITATION: Condensed water which falls to the earth's surface
B. SUPERCOOLED: Water vapor or liquid water that has not frozen even though the temperature is below the freezing point
C. DRIZZLE: Numerous fine drops, up to 0.5 mm in diameter that fall slowly to the ground
D. RAIN: Large drops up to about 5 mm in diameter that fall to the ground
E. VIRGA: Rain that evaporates before it reaches the ground
F. SNOW: Water in the solid state, usually occurring as six-sided crystals or stars
G. BLIZZARD: A violent snowstorm with strong, cold winds
H. SLEET: Rain that has frozen before it hits the ground. Sleet forms when rain falls through a layer of air that is below freezing, causing the raindrop to freeze
I. GLAZE: Supercooled raindrops that hit a surface and freeze on contact
J. HAIL: Rounded particles of ice, as small as a pea or as large as a baseball, that fall from cumulonimbus clouds

III. COMPARISON OF DROPLET SIZES:

A. CLOUD: About 0.2 mm in diameter.
B. DRIZZLE: Up to about 0.5 mm in diameter.
C. RAIN: Up to about 5 mm in diameter.

IV. THEORIES EXPLAINING THE FORMATION OF PRECIPITATION:

A. COALESCENCE PROCESS: The combining of two or more droplets into larger ones as a result of collisions.

1. In a cloud, the larger droplets, being heavier, fall faster than the small ones.
2. As they fall, they collide with smaller droplets along the way and capture or combine with them, growing still larger.
3. When they are large enough, they fall as precipitation.

B. ICE-CRYSTAL PROCESS: Supercooled water vapor in the air freezes on nuclei forming ice crystals which eventually fall to the ground.

1. Certain clouds have ice crystals in their upper parts that can act as "freezing nuclei."
2. Some supercooled water droplets in the cloud evaporate into the air, forming water vapor.
3. The water vapor condenses onto each ice crystal causing it to grow larger and heavier.
4. As each ice crystal grows heavier, it eventually falls.
5. As the crystals fall, they pick up other supercooled water droplets and grow by the "coalescence process."

C. THEORY OF HAIL FORMATION

1. A hailstone forms when a water droplet is blown into air that is below freezing.
2. The droplet freezes and then falls to a lower level where additional water condenses on the surface.
3. The frozen drop rises again, and this new water, collected on the outside, also freezes.
4. The more the hailstone repeats this up and down motion, the larger it becomes.
5. Eventually, the hailstone becomes so large that it falls.

FOLLOW-UP QUESTIONS ABOUT CLOUDS

TRUE OR FALSE: Determine whether each of the following is true or false. For each false statement, change the capitalized word(s) to the correct term(s).

1. Tiny droplets of water or ice crystals suspended in the air are called EVAPORATION NUCLEI.
2. Steam from a kettle is actually a CLOUD.
3. Thin, wispy, ice-crystal clouds are called NIMBUS clouds.
4. As air rises and flows over a mountain, the temperature COOLS, and a cloud forms.
5. A low-lying stratus cloud is called FOG.
6. The dark, gray clouds which provide the Earth with long periods of rain or snow are called CIRRUS clouds.
7. A cloud may form when a large body of air is cooled to its DEW POINT.
8. A thunderhead cloud is actually a CUMULONIMBUS cloud.
9. A vertical development cloud, generally indicating fair weather, is a CIRROCUMULUS cloud.
10. In a warm front, the sequence of clouds that usually leads to a long period of rain or snow is cirrus, cirrostratus, altostratus, and NIMBOSTRATUS clouds.

COMPLETION: Write in the word(s) which best complete(s) each statement.

1. The layer of the atmosphere reaching from the ground to an altitude of about 12 km is the ( ).
2. A tornado funnel generally originates in ( ) clouds.
3. Clouds composed of ice crystals belong to the ( ) family of clouds.
4. When the sun heats the land and the air, the air expands, becomes lighter, and ( ).
5. Water in the air condenses at the ( ) temperature.
6. Mare's tails clouds refer to ( ) clouds that are arranged in parallel streaks in the sky.
7. A professional weather observer is called a ( ).
8. For clouds to form, moist air must rise, cool, and ( ).
9. The ( ) type of cloud has the greatest range of altitude between its base and its top.
10. A ring around the sun or moon called a halo is formed by ( ) clouds.

THOUGHT QUESTIONS: Answer the questions below with simple statements.

1. What are the 4 basic steps in the cloud forming process?
2. List 4 ways in which air rises, cools, and forms clouds.
3. What are the 4 cloud families, and on what basis are they classified?
4. Describe the 2 types of clouds that produce rain.
5. What is the main difference, other than altitude, between high clouds and other families of clouds?

ANSWERS

TRUE OR FALSE

1. False, CLOUDS
2. True
3. False, CIRRUS
4. True
5. True
6. False, NIMBOSTRATUS
7. True
8. True
9. False, CUMULUS
10. True

COMPLETION

1. troposphere
2. cumulonimbus
3. high
4. rises
5. dew point
6. cirrus
7. meteorologist
8. condense
9. cumulonimbus (vertical development)
10. cirrostratus

THOUGHT QUESTIONS:

1. (1) Water leaves the air by evaporation or transpiration.
   (2) The moist air rises.
   (3) The air cools to the dew point.
   (4) The moist air condenses on condensation nuclei.
2. (1) The sun heats the air, causing the air to expand, become lighter, and rise.
   (2) Cold, heavy air moves over the land like a plow, pushing up the warm air in front of it.
   (3) Warm air moves over the land faster than cold air, and the lighter, warmer air is forced to move over the heavier, colder air.
   (4) Moving air pushes against a barrier such as a mountain, and has to rise over it to keep moving.
3. High, Middle, Low, Vertical Development. They are classified according to their altitude.
4. Nimbostratus: Dark, layered rain clouds.
   Cumulonimbus: Heavy, towering clouds with dark, flat bases, which rise like mountains.
5. High clouds are composed of ice-crystals. Other clouds are composed of water droplets.

FOLLOW-UP QUESTIONS ABOUT PRECIPITATION

MATCHING: Match the definition in Column B with the word in Column A.

COLUMN A	COLUMN B
1. sleet	a. particles on which water vapor in the air condense
2. rain	b. water vapor or liquid water that has not frozen, even though the temperature is below freezing
3. condensation nuclei	c. fine drops, up to 0.5 mm in diameter that fall slowly to the ground
4. hail	d. drops up to about 5 mm in diameter that fall to the ground
5. drizzle	e. rain that evaporates before it reaches the ground
6. glaze	f. water in the solid state, usually occurring as six-sided crystals or stars
7. supercooled water	g. a violent snowstorm with strong winds
8. snow	h. rain that has frozen before it hits the ground
9. virga	i. supercooled raindrops that hit a surface and freeze on contact
10. blizzard	j. rounded particles of ice which fall from cumulonimbus clouds

COMPLETION: Write in the word(s) which best complete(s) each statement.

1. The general term for condensed water, which falls to the Earth's surface is ( ).
2. Ice is likely to form on roads when roads when rain falls and the surface of the road is ( ).
3. The type of cloud generally associated with hail is ( ).
4. If rain passes through air that is below 0 degrees C or 32 degrees F, ( ) will form.
5. Coalescence in precipitation occurs when droplets ( ) with smaller ones to produce larger droplets.
6. Dust and salt, on which water vapor in the air condenses, are examples of ( ).
7. Drops, smaller than 0.5 mm, which float around inthe air rather than fall, making an umbrella almost useless are called ( ).
8. The biggest raindrops fall from ( ) clouds.
9. If 25 cm (10 in.) of rain were to fall as snow, the snow would be ( ) cm (in.) deep.
10. The different forms of precipitation cannot fall to the ground until they grow large enough to be pulled down by ( ).

THOUGHT QUESTIONS: Answer the questions below with simple statements.

1. How is precipitation related to the water cycle?
2. Why do you think ice will form on the wings of an airplane as it passes through a supercooled cloud?
3. Describe the five forms of precipitation that fall to the Earth's surface from clouds.
4. How does the coalescence process explain how cloud droplets become large enough to reach the ground?
5. How does the ice-crystal process explain how cloud droplets become large enough to reach the ground?

ANSWERS

MATCHING

1. h
2. d
3. a
4. j
5. c
6. i
7. b
8. f
9. e
10. g

COMPLETION

1. precipitation
2. below freezing
3. cumulonimbus
4. sleet
5. collide
6. condensation nuclei
7. drizzle
8. cumulonimbus
9. 250 cm (100 inches)
10. gravity

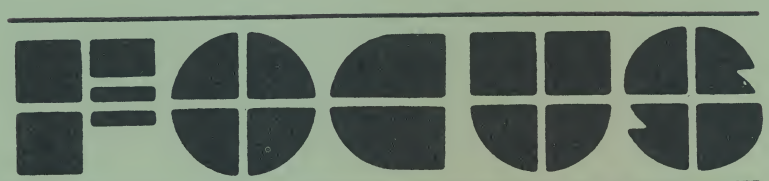
THOUGHT QUESTIONS:

1. Precipitation is the part of the water cycle that allows condensed water vapor to return to the Earth's surface.
2. The wings will serve as condensation nuclei for the supercooled water.
3. DRIZZLE: Fine drops, up to about 0.5 mm in diameter that fall to the ground
   RAIN: Large drops up to about 5 mm in diameter that fall to the ground
   SNOW: Water in the solid state, usually occurring as six-sided crystals or stars
   SLEET: Rain that has frozen before it hits the ground
   HAIL: Rounded particles of ice, which fall from cumulonimbus clouds after repeated up and down motions.
4. Large droplets fall through the air, colliding and combining with smaller droplets until they become large enough to fall.
5. Certain clouds have ice crystals in their upper parts that can act as "freezing nuclei." Some supercooled water droplets in the cloud evaporated into the air, forming water vapor. The water vapor condenses onto each ice crystal causing it to grow larger and heavier. As each ice crystal grows heavier, it eventually falls. As the crystals fall, they pick up other supercooled water droplets and grow by the "coalescence

THE AMOUNT OF WATER VAPOR IN SATURATED AIR

Temperature °C	Grams of water vapor per cubic meter of air	Temperature °C	Grams of water vapor per cubic meter of air
–2	4.0	16	13.0
0	4.8	18	16.0
1	5.2	20	18.2
2	6.0	22	19.4
4	6.4	24	22.0
6	7.5	26	23.5
8	8.1	28	25.0
10	9.3	30	30.0
12	10.7	32	34.0
14	11.4		

DRY-BULB THERMOMETER READINGS (°C)	DIFFERENCE BETWEEN WET- AND DRY-BULB THERMOMETER READINGS (°C)																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
10	88	77	66	55	44	34	24	15	6									
11	89	78	67	56	46	36	27	18	9									
12	89	78	68	58	48	39	29	21	12									
13	89	79	69	59	50	41	32	23	15	7								
14	90	79	70	61	51	42	34	26	18	10								
15	90	80	71	61	53	44	36	27	20	13	6							
16	90	81	71	63	54	46	38	30	23	15	8							
17	90	81	72	64	55	47	40	32	25	18	11							
18	91	82	73	65	57	49	41	34	27	20	14	7						
19	91	82	74	65	58	50	43	36	29	22	16	10						
20	91	83	74	66	59	51	44	37	31	24	18	12	6					
21	91	83	75	67	60	53	46	39	32	26	20	14	9					
22	92	83	76	68	61	54	47	40	34	28	22	17	11	6				
23	92	84	76	69	62	55	48	42	36	30	24	19	13	8				
24	92	84	77	69	62	56	49	43	37	31	26	20	15	10	5			
25	92	84	77	70	63	57	50	44	39	33	28	22	17	12	8			
26	92	85	78	71	64	58	51	46	40	34	29	24	19	14	10	5		
27	92	85	78	71	65	58	52	47	41	36	31	26	21	16	12	7		
28	93	85	78	72	65	59	53	48	42	37	32	27	22	18	13	9	5	
29	93	86	79	72	66	60	54	49	43	38	33	28	24	19	15	11	7	
30	93	86	79	73	67	61	55	50	44	39	35	30	25	21	17	13	9	5



MEDIA MEDIA MEDIA MEDIA MEDIA MEDIA MEDIA MEDIA MEDIA

FOCUS MEDIA, INC. 839 STEWART AVENUE GARDEN CITY, NY 11530